SCIENCE

VOL. 76 FRIDAY, NOVEMBER 25, 1932 No. 1978

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

SPACE STRUCTURE AND MOTION

By Dr. GUSTAF STRÖMBERG

MOUNT WILSON OBSERVATORY, CARNEGIE INSTITUTION OF WASHINGTON

INTRODUCTION

EVERYBODY is familiar with motion as an observed phenomenon. Motion, however, is not a simple thing, as we shall see in the following, and it has many aspects of extreme interest and far-reaching consequences. The most familiar kind of motion is that when I move my hand, for instance. This is a very complicated process involving human will, and most of our study must be confined to much simpler cases, although in the end we will include even such complicated motions in our picture. The simplest and most completely studied case is that of the motions of celestial bodies. Since we shall find that a study of these will give valuable clues for our interpretation of other motions, the writer will first give a description of these motions and of the properties of space which can be derived from them. We shall then find that these properties can be visualized by attributing to space a nearly uniform general structure. Close to atoms we shall also find that space has a fine-structure, and in living cells we shall meet with a fine-structure which may even be independent of matter.

When we determine motions, not by the use of measuring rods but by optical instruments, the following elements enter into our description. There is a moving body, there is an optical instrument—which in special cases may be the unaided eye, there is a space between the observer and the observed object and between several observed objects, there is a clock, and there is a light beam, or its equivalent, a stream of moving photons.

REFERENCE FRAMES

In studying the motions of particles, ordinary bodies, the planets in the solar system, the sun and

the stars in the galactic system, and of extra-galactic systems we can always describe the motions in different ways depending upon the nature of the reference frames we use. Since we use the incoming light beams in our measurements, the thing we study must obviously be connected with the laws of propagation and the nature of light. In the following I shall first try to show that there are two reference frames which are peculiarly adapted for our study. In the first, the observer is statistically at rest relative to the observable universe or has a uniform motion relative to it; in the second, the observer follows any one particular body freely moving in space. The first observer describes motions in terms of space and time intervals, the other in space-time intervals. The first description, which we will call the "kinematic," has the simplest geometry and gives information about space. The second, which we will call the "dynamic," has the simplest conception of force and gives information about the laws of motion.

Let us first see how we arrive at a kinematic description of motion. We attach a telescope to the earth and study the stars. All celestial bodies seem to turn around a point in the sky called the pole, which itself moves slowly among the stars. The planets move in rather complicated orbits relative to the stars. The near-by stars describe very small parallax ellipses in a period of a year, and all the stars move slowly relative to one another. The last two motions become vanishingly small for very distant objects. All the stars describe aberration ellipses with a semi-major axis of 20″ in a period of a year. The stars have also motions in the line of sight. Finally, the whole system of galaxies expands. The last two types of motions are determined by measuring the shifts of spectral lines, all the others by measuring angular displacements during definite time intervals.

Inertial Frames

To simplify the description we introduce what has been called an inertial reference frame. Such a frame is defined as non-rotating and non-accelerated. Since all definitions must be made in terms of observations, we must first describe the observational criteria, which determine whether a reference system is an inertial system or not.

Historically, an inertial system was defined as a coordinate system in which a body would move in a straight line with uniform velocity, when no gravitational forces were acting, or when they were compensated by appropriate bombardments by molecules in a direction perpendicular to the force (motion in a horizontal plane). Straight lines were defined by the direction of light beams in media of constant index of refraction or *in vacuo*.

Inertial frames can be determined by reference to the so-called "invariable plane" of the solar system and to the positions of planetary perihelia corrected for mutual attractions between the planets. The accuracy thus obtained is, however, not quite sufficient for precisional astronomy, in particular since we never know if the *empirical* gravitational laws used are exactly correct, or if small attractions from the outside are completely negligible. Instead of the inertial frame defined by moving bodies we now introduce an optical frame defined by moving photons (light beams). The deflections due to gravitational attractions are now very small and only noticeable when the light passes close by another star and proper *empirical* corrections can be applied. With this precaution we can use the optical frame as if it were a rigid frame.

Rotations

The rotation of the earth relative to the inertial frame can be determined without seeing any stars by observation of Foucault's pendulum. The earth's rotation relative to the optical frame can similarly be determined by the use of the interference method of Michelson.[1] In both cases the determinations are of insufficient accuracy.

We have also noticed that the stellar frame moves around the earth with the same angular speed (within the errors of observation) as the earth rotates relative to the inertial and optical frames. We then think of our optical frame as due to a *uniform* structure in space in which light is propagated with a constant, finite velocity in accordance with Euclidean geometry. The stars have small angular transverse motions relative to the same structure, but, by using distant galaxies instead of stars, we can reduce these motions to magnitudes below our observational errors—after corrections have been applied for the effects of yearly aberration—and our stellar frame becomes a rigid structure. We then make the assumption of exact coincidence between the rigid stellar frame, the optical frame and the inertial frame, and we can determine an exact value for the rotational velocity of the earth. The reference to the stars was, if our assumption was correct, for practical and not for principial reasons.

Accelerations

We shall now see how we can best determine if a reference frame is non-accelerated. The best way of determining small accelerations is by measuring effects of aberration. We then do not have to assume anything as to whether the motions of the observed stars are uniform or not.

Whereas the yearly and secular parallactic dis-

[1] *Astrophysical Journal*, 61: 137, 1925.

placements of the stars are simply explained as effects due to transverse motions of the stars relative to a frame whose origin is fixed in the earth and defined in direction by a few very distant objects, the large yearly swing of the light beams common to all stars in the same region of the sky and called aberration is more fundamental. The simplest and most obvious way of explaining it is by assuming the earth to have a non-uniform motion relative to an inertial frame in which light is propagated, or in which photons move, according to simple rules. For this reason, the observed object must not be too close, since in this case the motion of the observer is sensibly uniform during the time it takes light to travel from the source to the observer. The periodic aberration changes give a measure of the *observer's* acceleration, and the reference frame is the space structure characteristic for an inertial frame. If we used a reference frame fixed to the earth and if we used Euclidean geometry—as we have the right to do since the bending of the light beams due to the stars' attraction is entirely negligible, we must conclude that all the stars moved in ellipses whose linear size *increased* with increasing distance. Since we do not observe any masses, which we should expect to be associated with the tremendous accelerations of distant objects, we conclude that the acceleration so determined is a relation between the observer and the space around him and has nothing to do with the observed objects, except possibly in a statistical sense, which will be explained later.

A reference system fixed in the center of mass of the solar system can not have any large periodic accelerations without producing corresponding periodic aberration effects. Can we tell if it has an acceleration constant during a long time interval? The aberration measures the velocity of the observer relative to another inertial frame than the one in which he is at rest. If this velocity is constant no observable change is produced. If the aberration is different at two epochs, we can conclude that the motion of the observer is accelerated. It can easily be shown that the mean acceleration perpendicular to the line of sight is equal to the mean time-rate of change of aberration multiplied by the velocity of light. It seems now as if it should be easy to determine the constant acceleration of the sun simply by measuring the systematic proper motions of the stars, the aberration effects being separated from the parallactic displacements by making use of the fact that the latter decrease with increasing distance, whereas the former are independent of distance. It is not so simple, however. If the whole galaxy should have a uniform acceleration, the corresponding field of force would, according to the postulate of the general theory of relativity, bend the light beams just enough to exactly compensate for the aberration. We have then to use extra-galactic objects for our determination. We have reason to believe that the systematic proper motions of these objects do not exceed 0."01 per year, after corrections for yearly aberration have been applied. Hence we conclude that the acceleration of the sun and the galaxy as a whole can not exceed 0.00005 cm/sec^2. Relative to what is this acceleration measured? It certainly is not relative to the particular objects observed, since we know from observations of double stars that the accelerations of the individual stars have no effect on the aberration. If we used the same reasoning as we did for the earth's motion around the sun we would conclude that it was relative to the space structure characteristic for an inertial frame, and the acceleration could in this sense be termed "absolute." On the other hand, we must admit that we had to use external objects for its determination and, although the acceleration is not relative to the group of objects observed, it may still have some connection with the whole system of observed and unobserved cosmical objects.

The phenomenon seems to be very much the same as in the case of the "absolute" rotation of the earth. We can not measure the latter by observation of aberration effects on terrestrial light sources. In the first place, the effects would be inconceivably small, due to the fact that the velocity of the observer does not change appreciably during the short time it takes light to travel from a terrestrial object to an observer. In the second place, the relativity theory postulates that there would be strains in the earth and bending of light in the vertical plane, in which the measures have to be performed, which together would just compensate for the expected effects. One reason we still may think that the rotation of the earth is absolute is that it can be determined by measuring space derivatives instead of time derivatives, as Michelson has done.

We have now given the observational criteria needed for determining whether a reference frame is an inertial frame or not. The result is that a reference frame fixed to the center of mass of the solar system, rotating with the same speed as the system of extra-galactic objects, fulfills our requirements with a very high degree of precision. We must not forget, however, that an exact coincidence between the stellar frame and the inertial frame, so far as rotation was concerned, was assumed without proof.

The expansion of the system of galaxies does not produce any change in the angular separation of the galaxies, when measured from any one of them, since it is only a progressive change in scale.

The views expressed here about the nature of rotations and accelerations are not generally accepted,

but they are, I think, in harmony with those of Einstein. I quote from his Leyden lecture[2] of 1920: *"Newton might no less well have called his absolute space 'Ether'; what is essential is merely that besides observable objects, another thing, which is not perceptible, must be looked upon as real, to enable accelerations or rotations to be looked upon as something real."* The "other thing" (Kant's "Unding") has here been called "space structure."

The special theory of relativity postulates that all inertial systems are equivalent for the description of motion and of electromagnetic phenomena. By no means can we single out any unique inertial system which has other properties than all other inertial systems. This may well be true.

Uniform Motions

A few words may be added, however, about the effects of uniform motion relative to an inertial frame. If a body is moving relative to an observer it is contracted in conformity with Lorentz' expression. A moving clock goes slower than a similar stationary clock.[3] These are observable effects, dependent upon motion relative to an actual observer and can be regarded as due to the geometry of light propagation and the finite velocity of light equally well as to a property of space.

When light is traveling inside a moving transparent body the space structure is carried along with the material structure with a certain fraction of its velocity in conformity with Fizeau's formula. This is also an observable effect verified by interference experiments. We can then explain why the aberration is the same for a telescope filled with water and for one filled with air (Airy's experiment). From these considerations follows the addition law of velocities in the special theory of relativity, and an upper limit can be deduced for the *observed* velocity of a body relative to an observer.

Relativity Effects in Kinematic Terms

We can go a few steps further in our kinematic description. By a slight modification of our law of gravitation and by giving mass to a photon we can "explain" the motion of the perihelion of Mercury and the deflection of a beam of light near the sun's limb, provided we determine these effects *empirically*. There still remains the red-shift of the general relativity theory. We have *empirical* reasons to believe that a photon has a mass and carries momentum and energy. The sun's gravitational field holds back the photon and it loses momentum and energy. Since it can not change its velocity, the loss of "kinetic" energy must correspond to a reduction of the frequency, and we arrive at the same formula as that given in the general theory of relativity, seemingly verified by observations. We conclude that the original frequency of the light emitted by a certain transition in an atom was originally the same as for a similar atom on the earth.

To summarize the kinematic description, we can make the following statements. Rotations and accelerations are not determined relative to any observable bodies, but can be regarded as referred to the uniform space structure of an inertial frame, and are in this sense absolute. Euclidean geometry can be used for light beams if we apply the proper corrections due to gravitational forces and to the finite velocity of light. All inertial systems are equivalent for the kinematic description of motion; in particular is the *measured* velocity of light the same in all of them. There may exist a unique inertial frame in which light travels with a unique velocity, but since we can not observationally discriminate between such a frame and other inertial frames, this conception may be an illusion. These statements do not lead to any discrepancy with observations hitherto made.

Dynamic Description

The kinematic description of motion has in its favor the simplest possible geometry, but it leaves the forces out as something extraneous and disturbing, not explicable in quite the same language as inertial motion. Einstein's general theory of relativity has made it possible to express inertial and non-uniform motion as being both properties of a non-uniform space-time structure. The motion is now always uniform or zero, but our new reference frame in space and time is different here and there, now and then. In other words, it is distorted, particularly so in the neighborhood of what we call matter. Particles, photons and stars follow "world-lines" in space and time. The world-lines are dependent upon gravitational potentials, and when two world-lines meet we have an *"event"* observable in space and time. The potentials determine the space-time geometry, which is now empirical, to be determined by measurements in space and time.

This is not the place to go into any details of the general theory of relativity. For our purpose it is sufficient to say that a modification of Newton's law of gravitation can be derived from the assumption of equality of all reference frames of the same "kind."

[2] "Ether and Relativity," *Sidelights on Relativity*, Methuen, 1922.

[3] There is also an effect of the first order in v/c (Doppler effect), which may make the clock appear to go faster or slower, according as it approaches or recedes from the observer. After this has been allowed for, there remains a second order effect here referred to.

Several of the relations mentioned in the kinematic description can be derived without introduction of new empirical constants, which relations have been verified by observations. An important consequence is that of the equivalence between mass (matter) and energy. Since motion is dependent upon space-time structure, which in its turn is dependent on matter, it must of necessity be relative to matter or rather to the metrical field associated with matter. By arbitrary transformations of coordinates we can introduce new acceleration fields, which are identical with gravitation fields, except that they are not associated with matter. For an *actual* freely moving observer the actual field equations must be used, and we then always find matter associated with the acceleration fields.

(To be concluded)

OBITUARY

WILLIAM PATTEN

STILL vigorous and actively engaged in scientific research at the age of 71, Dr. William Patten suddenly and peacefully passed away at Hanover, New Hampshire, on October 27, 1932. He had just returned from an expedition to the Baltic Island of Oesel, Esthonia, where during the summer with a large corps of workmen he had exhumed and shipped to Dartmouth College a large collection of primitive fossil fishes, chiefly small, delicate Ostracoderms. It had been a successful expedition, and he felt that, after three seasons of intensive work, the region visited had been thoroughly explored.

His enthusiastic, day-and-night application to the preliminary survey of his fossils was too strenuous. Six days before his death a painful heart attack struck him down. He rallied and hoped soon to return to his work, when suddenly, by coronary thrombosis, the end came.

Born at Watertown, Massachusetts on March 15, 1861, the youngest son and next to the youngest child in a family of 14 children, his bent toward zoology was shown, even before he entered the Lawrence Scientific School of Harvard University, by his interest in ornithology and anatomy. While in college he paid his expenses in part by work at taxidermy and the illustration of scientific books. As a freshman he won the Walker Prize of the Boston Society of Natural History by a paper on the "Myology and Osteology of the Cat," work which had been done mostly before entering college.

Professor E. L. Mark, under whom he studied zoology at Harvard, found him a brilliant student, independent and energetic. He was also under Professor Shaler's stimulating influence. His perennial interest and skill in athletics was shown by his position as catcher on the Watertown baseball team; his love of music by his membership as a tenor in the Harvard College choir and glee club.

He received the B.S. degree in 1883, was awarded a Parker traveling fellowship and married Mary Elizabeth Merrill, of Bradford, Massachusetts, who became his lifelong companion.

Studying at the University of Leipzig under the distinguished zoologist, Leuckart, he received the degree Ph.D. at the end of the first year (1884). Two years of research followed, first at the Zoological Station at Trieste, then at Naples. Returning to America in 1886, he was for three years assistant to Dr. C. O. Whitman at the Allis Lake Laboratory at Milwaukee. His son, Dr. Bradley Merrill Patten, associate professor of histology and embryology at the Western Reserve University School of Medicine, was born at Milwaukee in 1889. From 1889 to 1893 William Patten was professor of biology at the University of North Dakota.

Coming to Dartmouth College as professor of biology in 1893, he brought with him a strong urge toward research. Soon there were graduate students working under his instruction on *Limulus* and arachnid embryology. While teaching comparative anatomy of vertebrates and embryology, which he did for 25 years, he organized a course centered about organic evolution.

Desirous of contacts with younger students, he undertook in 1920–21 the organization and became the director of the freshman course in evolution, which he conducted with the cooperation of several associates until his retirement from teaching in June, 1931, at the age of 70, at which time he received from Dartmouth the honorary degree of Sc.D.

His scientific publications between 1884 and 1889 were upon the embryology of insects (Phryganids) and mollusca (*Patella*) and upon the eyes of mollusks and arthropods, described in extensive papers with clear and beautiful illustrations. From 1889 to 1900 his work centered about the king crab, *Limulus*, especially its nervous system and embryology. The first statement of the theory which dominated his later research, "On the Origin of the Vertebrates from Arachnids," appeared in the *Quarterly Journal of Microscopical Science* in 1889. This hypothesis was also elaborately developed and illustrated with a wealth of new observations in his book, "The Evolution of the Vertebrates and Their Kin," published in 1912.

Since 1900 his numerous papers have followed two quite different lines, paleontology of primitive fishes,

the Ostracoderms, and those on social philosophy. The latter were the outcome of the idea that harmonious cooperation is a necessary factor in evolutionary progress, which he developed in his book, "The Grand Strategy of Evolution; the Social Philosophy of a Biologist," published in 1920. That year he organized the freshman course in evolution at Dartmouth, in which he at first used this as a text-book but later wrote and published for the use of his students a series of pamphlets in which his social philosophy was further developed and various principles of biology were discussed.

As a paleontologist he scoured the world for new material. Seven summers between 1902 and 1914 were spent in field work and collection of fossil fishes in northern New Brunswick, a search which extended into Newfoundland and Labrador and was the source of the fine collection of *Bothriolepis* at Dartmouth College, of which he made an exhaustive study.

In search of scorpions and other arachnids, he visited, with Mrs. Patten in 1912, New Guinea, Australia, Java, and sought the far-eastern representative of *Limulus* in Japan. In 1912 he traveled in Costa Rica and Cuba. During the last seven years of his life he made in all four trips to the Baltic countries after ostracoderms, and in 1925 went on to Spitzbergen.

With extraordinary talent as an artist, he had an artist's impulsive temperament and keen imagination. Infinitely patient in the search for structural details of an organism, he never failed to find in these facts a meaning. To him *Bothriolepis*, for example, was no mere fossil, but the embodiment of a cherished ideal, a link between two great phyla. Fortunately, he found this primitive fish so perfectly preserved that it needed no restoration but awaited only patient, skilful investigation and an interpretation.

His tenacity of purpose was unflinching; he attacked his work with the vigor and strategy of a general at war, almost fiercely. Never dependent upon others for ideas, he occupied himself very little with the discoveries of his predecessors, but pushed on independently, boldly. His thought was stimulating, whether one agreed with him or not.

The importance of harmonious cooperation as a *sine qua non* to evolutionary and social progress, brought out in his book, "The Grand Strategy of Evolution," appealed to him as a fresh discovery, for he was emphatically a rugged individualist.

But this philosophy, as he dwelt upon it, probably had more than a little to do with the development of that genial, friendly spirit which was always latent in him, even at that earlier period when he went fiercely to his work.

A fine physique and fondness for outdoor and indoor games kept him perennially young. Still a graceful figure skater at 70, it was his great delight in winter to teach his neighbors' daughters to waltz upon the ice. At carnival competitions his services as judge were always in demand.

He was never more happy than when explaining his work to those who showed interest and appreciation; it was a pleasure to follow the progress of his anatomical and paleontological research, presented with drawings and plastic models of remarkable clearness and beauty.

An independent, original thinker and stimulating teacher, he seemed at 70 still at his prime. His scholarship expanded and ripened with advancing years; grim determination gave way to broader human sympathies. A many-sided, vigorous, imaginative thinker, he had the vision and talent of an artist and sculptor, combined with extraordinarily keen and infinitely painstaking powers of observation.

JOHN H. GEROULD

SCIENTIFIC EVENTS

THE HARVARD ANTHROPOLOGICAL SURVEY OF THE IRISH FREE STATE

HARVARD anthropologists have begun a five-year study of the Irish Free State. They hope to include in it surveys of the social and economic life of the Irish people of the present and the past, their material civilization and their racial characteristics. These researches will be correlated in an attempt to produce some sort of scientific interpretation of the Irish nation.

In the summer of 1931 two experts were sent to Ireland to make a preliminary survey in order to determine the most suitable areas for the concentration of research and to ascertain whether such a study would be welcomed by the Irish people. The project was cordially received by all classes and parties and this year has been accorded the official approval of the President of the Irish Free State.

County Clare has been selected as the focus of sociological research because it seems to blend most typically the new and old strata of Irish Gaelic culture, being neither over-modernized nor ultra-conservative. During the past year, Conrad Arensberg, a graduate student in anthropology at Harvard, has been preparing himself for sociological work in Ireland by studying at the National University. This summer W. Lloyd Warner, assistant professor of sociology in Harvard University, began with the help of Mr. Arens-

berg the study of the economic and social life of County Clare. Many aspects of Irish social life were examined, including the marketing system, land tenure, political institutions, the family, etc. At least two years of full-time work with an enlarged staff will be required before the necessary data are collected.

This year the archeological phase of the work was also successfully begun under the leadership of Dr. Hugh O'Neill Hencken, assistant curator of European archeology in the Peabody Museum of Harvard University, and Hallam L. Movius, Jr., of Harvard University. The excavations were conducted under the auspices of the National Museum of the Irish Free State, which will be the recipient of all archeological finds.

The first site investigated was a crannog or lake-dwelling of the tenth century A. D., at Ballinderry, near Moate, County Westmeath. Here the archeologists completed the most thorough investigation of such remains hitherto carried out in Ireland. The crannog was an immense wooden building erected on a platform of logs in the center of the lake and surrounded by a high palisade of stakes. Among the finds were truck loads of bones of wild and domesticated animals, remains of wooden tubs and barrels, iron knives, axes, bone combs and bronze pins. The most important discoveries were a bronze, heart-shaped oil lamp, ornamented in Keltic style, and a curiously carved Viking gaming-board. Both of these are unique.

Another successful excavation was carried out on the six hundred foot hill of Knockast, where a huge cairn, or stone grave, was explored. This yielded forty-three burials belonging to the Bronze Age, mostly cremations. A considerable assortment of implements was found. Many other sites must be explored in future seasons, since the archeology of Ireland is almost unknown.

The anthropometric or racial survey of the Free State will be under the direction of E. A. Hooton, professor of anthropology at Harvard University, who is also in general charge of the entire Irish project. The field work in physical anthropology will be deferred until the other aspects of the study are well under way.

THE NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING

THE Tenth National Exposition of Power and Mechanical Engineering is to be held at the Grand Central Palace, New York, from December 5 to 10, inclusive, and runs concurrently with the annual meetings of The American Society of Mechanical Engineers and The American Society of Refrigerating Engineers. It will be open daily from 12 noon until 10:30 P. M.

Features of the exposition include the products of three hundred manufacturers of power and mechanical equipment. Among the distinctly new things to be seen will be control devices of unique design, including a three-element water-level control; a new type of temperature control designed to eliminate hunting; a differential draft-control system; a device for controlling the fuel level in ball mills; and a new type of mechanical steam-flow meter. Many new designs of instruments will be seen, including high-pressure steam gages, fluid meters, condensation meters, recording thermometers and gages for distant pressure recording. Two distinctly new types of expansion joints will be shown for the first time. There will also be on view a superheater especially developed for return-tubular boilers.

The results of research will be reflected in many valves and fittings of alloy steels developed to meet the conditions imposed by the trend toward higher steam pressures and temperatures. Also the progress in welding within the last few years will be depicted by the display of welding fittings and fusion-welded boiler drums.

There will be an exhibit of chlorination methods which will give the visitor an opportunity to see by means of the microscope how the marine growths actually accumulate and how they can be effectively eliminated.

Two new types of oil burners will be exhibited, one of the wide-range mechanical-atomizing type and the other of the steam-atomizing type for burning refinery waste.

Among the many other new things may be mentioned a device for removing free air from condenser circulating water; a new type of vibration damper; and a hydraulic coupling for use between motors and fans. One manufacturer will show a thermodynamic motor deriving its power from the surrounding atmosphere.

The subject of atmospheric pollution will be treated from several angles, such as its economic aspect, methods of measurement, effect on the human system, research and progress in abatement. The New York City Department of Health, the Mellon Institute, the New York Meteorological Observatory of the U. S. Weather Bureau, Stevens Institute of Technology, the Pure Air Committee of the American Society of Mechanical Engineers and a number of smoke enforcement bodies are cooperating in this exhibit.

For Saturday morning there is being arranged a specially conducted inspection of the exposition by upperclassmen in several of the universities within convenient traveling distance. This tour will be preceded by addresses from prominent engineers from

the fields of mechanical engineering, refrigeration and heating and ventilation.

APPROPRIATIONS OF THE CARNEGIE CORPORATION

APPROPRIATIONS amounting to $5,256,000 to colleges, universities and other educational organizations were made by Carnegie Corporation during its fiscal year ending September 30, 1932, according to the report of President Frederick P. Keppel. These grants were for a wide variety of specific purposes within the fields of library service, adult education, the arts, scientific and educational research and publication.

Library activities received $873,000, one quarter of which was for purchase of books in twenty-one four year liberal arts colleges, scattered in fifteen states. Two colleges—Lafayette and Wesleyan—received $150,000 each for endowment of the college librarianship.

Three other institutions received endowment grants for various purposes: Stanford University, for the Food Research Institute, supported for a decade by the corporation and now turned over to the university, $750,000; Upper Canada College, $150,000, and Atlanta University, for endowment of a professorship in the school of business, $100,000.

The list of gifts devoted to scientific research includes subsidies for investigations of cosmic rays, both by Professor Millikan and by Professor Compton, on leukemia, solar radiation, cortin, vitamins, velocity of light, and in metallurgy; to educational research looking toward the improvement of instruction in colleges and universities, cooperation between secondary schools and colleges, appraisal of techniques of educational guidance, internal administration of colleges, effect on character of different types of education, economic factors in the practice of medicine, mental disorders, the psychology of later maturity, and the like. These account for $656,000.

Adult education, for which the largest grant was $150,000 to the American Association for Adult Education, received a total of $368,500. *The Journal of Adult Education*, now accepted as a standard publication, was aided by a subsidy of $15,000; the American Foundation for the Blind, for experiments in phonographic reproduction of books, $10,000; the University of Minnesota, for study of re-education of the unemployed, $25,000, and the Workers Education Bureau of America, for its program, $12,000.

In the list of institutions receiving aid for development of their fine arts programs are found: The University of Alberta, $30,000; Brown University, for a cooperative arts program with the community, $15,000. For its summer courses for arts teachers, the American Institute of Architects received $15,000; the Museum of the City of New York, $52,500; the New York Botanical Garden, $12,000; the American Federation of Arts, $30,000, and the College Art Association, for various activities, $55,000.

The corporation administers under its charter two funds: a major one, the income of which is to be spent in the United States; the other of $10,000,000, of which the income is applicable in the British Dominions and Colonies. From the latter fund, grants were made in South Africa, Australia, New Zealand, Canada and other places, for purposes similar to those prevailing under the larger funds.

FOREIGN GUESTS AT THE CENTURY OF PROGRESS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THERE have been printed in SCIENCE (July 24 and August 21, 1931) articles by Colonel John S. Sewell, director of exhibits, describing the plans for the basic sciences at the Chicago Centennial Exposition and for invitations of foreign guests to attend the meeting of the American Association for the Advancement of Science and its affiliated societies to be held in June. The committee on foreign guests appointed at the Cleveland meeting of the association selected, with the cooperation of the sections of the association, the divisions of the National Research Council and the national scientific societies, a distinguished group of scientific men, representing the different sciences and the different nations to whom invitations were sent signed by Mr. Rufus Dawes, president of the exposition, and Professor John J. Abel, president of the association. A joint meeting of officers of the Century of Progress and the committee of the association was held in Chicago on November 12, and it was reported that acceptances had been received as follows:

MATHEMATICS

Leopold Fejér, Budapest
Tullio Levi-Civita, Rome

PHYSICS AND METEOROLOGY

J. Bjerknes, Bergen
Niels Bohr, Copenhagen
Enrico Fermi, Rome
A. Sommerfeld, Munich

CHEMISTRY

F. W. Aston, Cambridge
George Barger, Edinburgh
Robert Robinson, Oxford
P. Karrer, Zurich
T. Svedberg, Upsala
J. N. Brønsted, Copenhagen

GEOLOGY AND GEOGRAPHY

Albrecht Penck, Berlin
J. J. Sederholm, Helsingfors

ZOOLOGY, PHYSIOLOGY AND ANATOMY

A. V. Hill, London
R. Goldschmidt, Berlin
August Krogh, Copenhagen
Joseph Barcroft, Cambridge
Filippo Bottazzi, Naples

BOTANY

Ludwig Diels, Berlin

PSYCHOLOGY

Emilio Mira, Barcelona
Henri Pieron, Paris
Charles E. Spearman, London

SOCIAL SCIENCES

G. A. Bagge, Sweden
Albrecht Mendelssohn Bartholdy, Hamburg
Henry Clay, Manchester

ENGINEERING

A. P. M. Fleming, Cheshire, England

MEDICAL SCIENCES

Ludwig Aschoff, Freiburg
C. U. A. Kappers, Amsterdam
C. Levaditi, Paris
Cl. Regaud, Paris

AGRICULTURE

Otto Appel, Berlin-Dahlem
Jean Dufrénoy, Brive, France
Sir Daniel Hall, London

SCIENTIFIC NOTES AND NEWS

THE medals of the Royal Society have been awarded as follows: Royal Medals to Professor R. Robinson, for his work in organic chemistry and to Professor E. Mellanby, for his work on dietary factors, especially in connection with rickets; the Copley Medal to Dr. G. E. Hale, foreign member of the Royal Society, for his work on the magnetic field of the sun; the Rumford Medal to Professor F. Haber, for his work in the application of thermodynamics to chemical reactions; the Davy Medal to Professor R. Willstätter, for his researches in organic chemistry; the Darwin Medal to Dr. C. E. Correns, for his researches in genetics; the Buchanan Medal to Professor T. Madsen, for his work on immunity, especially in relation to diphtheria antitoxin, and the Hughes Medal to Dr. J. Chadwick, for his researches on radioactivity.

THE following are recommended by the president and council for election to the council of the Royal Society at the anniversary meeting on November 30: Sir Frederick Hopkins, *president;* Sir Henry Lyons, *treasurer;* Sir Henry Dale and Sir Frank Smith, *secretaries;* Lord Rayleigh, *foreign secretary. Other members of council:* Dr. J. A. Arkwright, Professor W. L. Bragg, Professor C. H. Desch, Dr. G. M. B. Dobson, Mr. A. C. G. Egerton, Dr. J. Gray, Professor A. V. Hill, Professor A. Hutchinson, Professor J. E. Littlewood, Professor E. Mellanby, Professor R. Robinson, Dr. N. V. Sidgwick, Professor A. G. Tansley, Professor D'A. W. Thompson, Dr. W. Trotter and Mr. G. U. Yule.

IN connection with the recent award of a Nobel Prize to Sir Charles Sherrington and Professor E. D. Adrian, *Nature* states that since the foundation of the Nobel Trust in 1901, seventy-six prizes for physics, chemistry and physiology and medicine have been awarded, of which fifteen have gone to scientific men working in Great Britain. The latter are distributed as follows: *Physics:* Lord Rayleigh, 1904; Professor, now Sir, J. J. Thomson, 1906; Professor, now Sir, William Bragg, jointly with Professor W. L. Bragg, 1915; Professor C. G. Barkla, 1917; Professor C. T. R. Wilson, 1927, jointly with Professor A. H. Compton, University of Chicago; Professor O. W. Richardson, 1928. *Chemistry:* Sir William Ramsay, 1904; Professor Ernest, now Lord, Rutherford, 1908; Professor Frederick Soddy, 1921; Dr. Francis W. Aston, 1922; Professor Arthur Harden, 1929, jointly with Professor von Euler. *Physiology and Medicine:* Sir Ronald Ross, 1902; Professor Archibald V. Hill, 1922, jointly with Professor Otto Meyerhof; Sir Frederick Gowland Hopkins, 1929, jointly with Dr. Eijkman; Sir Charles Sherrington and Professor E. D. Adrian, 1932.

AT the University of Chicago, Professors E. H. Moore and H. E. Slaught have retired from active service in the department of mathematics, with the title of professor emeritus. Both have been in the university since it opened its doors in the autumn of 1892. Professor Moore was acting head of the department from 1892 to 1896, and head from 1896 until 1931, when he gave up his administrative duties. He was one of the founders of the Chicago Section of the American Mathematical Society and one of the first editors of its *Transactions.* He has been president of the society and of the American Association for the Advancement of Science, and for many years an associate editor of the *Proceedings* of the National Academy of Sciences. Professor Slaught was a fellow in mathematics at the University of Chicago from 1892 to 1894, and was one of the first group of graduate students who received the Ph.D. degree in mathematics from the university. From 1894 on he has been a member of the staff of the department of mathematics. He was a central figure in the found-

ing of the Mathematical Association of America, and has been for many years a managing editor of its official journal, *The American Mathematical Monthly*. He has served the American Mathematical Society in numerous other capacities and has been president of the Mathematical Association. The correspondent who sends this information writes: "For an adequate record of the services of such men as these, books, not paragraphs, are needed."

RITTER HALL is the name that has been given to the new laboratory building of the Scripps Institution of Oceanography at La Jolla, California, in honor of Dr. William Emerson Ritter, first director of the institution. A suitable inscription, carved in raised letters on a plaque of Mexican mahogany, has been placed in the entrance hall. Dr. Ritter was the first professor of zoology at the University of California, and since his retirement as director of the Scripps Institution has returned to Berkeley, where he is continuing his zoological researches.

DR. FRANK R. LILLIE, professor of embryology and dean of the division of the biological sciences, has been appointed vice-chairman of the faculty of the School of Medicine of the Division of Biological Sciences of the University of Chicago.

THE Seismograph Station of the University of Pittsburgh has recently been transferred to the department of geology, of which Professor H. Leighton is head. H. Morgan Rutherford, of the University of Texas, has been appointed assistant in geology and will be in direct charge of the station.

HAROLD S. OLCOTT, last year National Research fellow in medicine at the department of physiological chemistry, Yale University, has been appointed research associate in biochemistry at the State University of Iowa.

TYRRELL H. WERNER, for the past two years research assistant in chemistry at Harvard University, has become research associate in chemistry at the Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Maine.

AT the University of Manchester, Dr. John Hollingworth has been appointed to succeed Professor Miles Walker, who has held the chair of electrical engineering at the university and the College of Technology since 1912.

AS a special tribute, the Clinical and Pathological Society, Denver, elected Dr. Robert Levy president for the third time on the fortieth anniversary of its organization. He was the first president of the society and was again president in 1922, the thirtieth anniversary of the society.

DR. J. C. FUTRALL, president of the University of Arkansas, was elected president of the Association of Land Grant Colleges at the recent convention of the association at Washington, D. C. T. O. Walton, president of the Agricultural and Mechanical College of Texas, was elected vice-president; Thomas P. Cooper, dean of the University of Kentucky College of Agriculture, was again named secretary-treasurer, and President R. A. Pearson, of the University of Maryland, chairman of the executive committee.

AT the Philadelphia meeting of the American Academy of Physical Therapy, officers were elected as follows: *President,* Dr. William L. Clark, Philadelphia; *Vice-president,* Dr. Frank H. Krusen, Philadelphia; *Secretary-Treasurer,* Dr. Arthur H. Ring, Arlington, Massachusetts; *Assistant Secretary-Treasurer,* Dr. Robert C. Hughes, Paoli, Pennsylvania.

AT a meeting of the New Mexico Association for the Advancement of Science (affiliated with the American Association for the Advancement of Science), held in Roswell, N. M., on November 3 and 4, the following were elected as officers for 1933: *President,* Dr. Sterling B. Talmage, professor of geology at the New Mexico School of Mines, Socorro; *Vice-president,* Dr. Hoyt C. Graham, professor of chemistry at the State Teachers College, Silver City; *Secretary,* Eldred R. Harrington, of the Albuquerque High School, Albuquerque; *Treasurer,* Reginald Fisher, of the New Mexico Museum at Santa Fé.

DR. C. MAX BAUER, formerly with the United States Geological Survey, has been appointed naturalist in charge of research and education in Yellowstone National Park.

DR. HERBERT M. EVANS, professor of anatomy at the University of California, is spending a year working as a guest of the Rockefeller Institute of Medical Research, New York.

DR. H. B. VAN DYKE, professor of pharmacology in the University of Chicago, has sailed for China, where he is on the staff of the Peiping Medical College.

DR. WALTER N. KOELZ, Asiatic expert from the University of Michigan Museum, will spend the winter beyond the outer passes of the Himalayas, in the Kangre Valley, in order to make a study of the life and habits of the people and bring back examples of their art work and handicraft, as well as plant and animal specimens.

DR. FRANK R. LILLIE, professor of embryology at the University of Chicago, will deliver the Charles Sumner Bacon Lectures at the College of Medicine of the University of Illinois on December 7 and 8.

His general subject will be "Problems in the Biology of Sex." The titles for the separate lectures are "Biology of the Ovary in Birds" and "The Effects of the Female Sex Hormone in Birds and the Nature of Sex Characters."

THE speaker for the first meeting of the Sigma Xi Club of the University of Florida on November 2 was Dr. O. L. Tinklepaugh, of the Yale Anthropoid Station, Orange Park, Florida. Dr. Tinklepaugh discussed some aspects of reproduction in primates and closed with a motion picture film.

SIR JAMES C. IRVINE, principal of the University of St. Andrews, Scotland, an authority on the chemistry of the sugars, lectured at Yale University on November 14 on "New Developments in the Chemistry of Starch and Cellulose."

SIR ARTHUR EDDINGTON gave an address on "Physics and Philosophy" under the auspices of the British Institute of Philosophy at University College, London, on November 15. The chair was taken by Bertrand Russell.

THE eighth annual Norman Lockyer Lecture of the British Science Guild was delivered by Sir Frank Smith in London, on November 22. He spoke on "Industrial Research and the Nation's Balance Sheet."

As reported in the *Journal* of the American Medical Association, the Henry M. Hurd Memorial Building, the Osler Medical Clinic and the Halsted Surgical Clinic, representing a direct outlay of nearly $2,000,000 in addition to an endowment of more than $3,000,000, were dedicated at the Johns Hopkins Hospital, on October 28. An anonymous donor provided the endowment. Dr. Joseph S. Ames, president, the Johns Hopkins University, presided at the dedication. Dr. John M. T. Finney, professor of clinical surgery, gave the Halsted Surgical Clinic dedicatory address, and Dr. William S. Thayer, professor emeritus of medicine, that for the medical clinic. Mr. Henry D. Harlan, president of the board of trustees, gave a eulogy of Dr. Hurd. The building, housing the two clinics, was completed at the Johns Hopkins Hospital last year at a cost of $1,740,000, of which $500,000 was provided by the General Education Board. The clinics are memorials to the late Dr. William S. Halsted, first professor of surgery, and the late Sir William Osler, first professor of medicine at the Johns Hopkins University School of Medicine.

THE Cambridge Philosophical Society celebrated the centenary of the grant of a Royal Charter by a dinner on November 5 held in the hall of Pembroke College. The Master of Pembroke, president of the society, was in the chair. The chancellor of the university, the president of the Royal Society, Prince George and representatives of many scientific societies were present. The toast of the society was proposed by the Prince and replied to by the president. The master of Trinity College, Sir J. J. Thomson, proposed the health of the guests and there were replies by the chancellor and Sir William Bragg.

THE American Soil Survey Association and the American Society of Agronomy held their sessions at Washington, D. C., from November 15 to 18. Members of the two associations discussed soil and crop practices and problems of the soil survey which has covered more than half the arable lands of the United States. In a joint program of the two associations, on November 17, problems of mutual interest, such as plant growth and crop yields in relation to soil fertility and soil type, were discussed. There was a series of discussions on the origin, characteristics and agricultural possibilities of the leading soil families of the United States, including the podsols of New England, the brown forest soils of the Northern States, the prairie soils of the West, and the solonetz soils of California. Dr. Curtis F. Marbut, chief of the division of soil survey of the Bureau of Chemistry and Soils, spoke on the relation of the soil survey to the work of the U. S. Department of Agriculture in developing a land classification upon which to base a federal program for agriculture. Dr. H. G. Byers, of the Bureau of Chemistry and Soils, opened the discussion on the chemical constitution of soil colloids. Several bureaus of the government and many state colleges and experiment stations were represented at the meetings.

THE forty-eighth annual meeting of the Association of Official Agricultural Chemists was held in Washington, from October 31 to November 2. Members of the Bureau of Chemistry and Soils, the Food and Drug Administration, the Bureau of Animal Industry and of the faculties of state colleges and experiment stations, joined in consideration of various phases of agricultural chemistry. Dr. A. F. Woods, director of scientific work of the department, addressed the opening session, welcoming the association to Washington on behalf of the Department of Agriculture. Discussions at the meeting were concerned principally with the practical application of chemistry to foods, drugs, beverages, feedstuffs, insecticides and fertilizers, in which the association has played an important part in the development of new methods of research and in assisting the effort of the department toward purity and honesty in manufacture. The association elected the following officers for the coming year: J. H. Kellogg, Pennsylvania State Department of Agriculture, Harrisburg, *president;* R. Harcourt, Guelph, Canada, *vice-president,* and W. W. Skinner,

U. S. Bureau of Chemistry and Soils, Washington, D. C., *secretary-treasurer.*

THE annual agricultural outlook conference for the Southern States was held at Atlanta, Georgia, from November 8 to 11. Representatives of the department and of most of the agricultural colleges, experiment stations and extension services in the South attended. Outlook reports will be issued on agricultural credit and demand, tobacco, fruits, truck crops, potatoes, rice, sugar, cotton, poultry, dairy products, hogs, beef cattle, sheep, feed crops, farm labor, farm equipment and fertilizers. On the closing day there were round-table discussions of outlook extension and farm-management extension work, and reports on developments in marketing and cooperative purchasing and on the effects of changes in transportation upon marketing problems.

A GARDEN of native plants has this year been established in the part of the alluvial fan directly behind the Yosemite Museum, Yosemite National Park. Planting was begun last April on a two-acre plot, flagstone walks were installed, and a spring developed to supply a running stream and pools. The work was made possible by a gift of $4,000 by Miss Marjorie Montgomery Ward.

MRS. CARLOS F. MACDONALD, widow of the late Dr. Carlos F. MacDonald, a distinguished psychiatrist, of New York, died in Atlantic City on November 5. On May 7, 1928, Mrs. MacDonald established a trust fund, in memory of her husband, to be known as the "Carlos Frederick MacDonald Research Fund," and held in trust by The Girard Trust Company. The income of this fund is used by the Wistar Institute in the promotion of biological research and the publication of research in any Wistar Institute journal. By Mrs. MacDonald's will this fund eventually will be very greatly increased.

AT a recent meeting of the council of the Royal College of Surgeons it was announced that Sir Buckston Browne had now completed his gift of £100,000 for building and endowing the Surgical Research Farm at Downe, Kent.

THE University of Oslo has received a gift of 20,000 kronen from a Norwegian chocolate factory for the foundation of a chair on the physiology of nutrition.

DISCUSSION

EMANUEL SWEDENBORG ON THE THEBESIAN SYSTEM OF THE HEART

THE comparative recency of the published appreciations of Retzius,[1] Ramström,[2] Nordenskiöld[3] and others, shows how long the world at large had been content to permit the luster of Swedenborg the theologian to obscure its estimate of Swedenborg the biological thinker. Pioneer in many fields of the intellect, this gifted physicist and engineer (1688–1772) turned in middle life to the intensive acquisition of the anatomy and physiology of his day. Making full allowance for the tendency to mystical interpretation during this transitional phase of his career, Swedenborg's contributions to biological theory—especially neurological—were noteworthy, and to a degree that has failed of adequate notice even within the present century.

His work on the circulation is essentially unknown to science. Of peculiar interest to the writer has been that part dealing elaborately with the coronary system; for it is here discovered[4] that Swedenborg was the first to conceive of the Thebesian vessels (and their foramina in the inner walls of the heart) as subserving an entrant, nutritional function. To Swedenborg the coronary arteries—on evidence which the present day must find it hard to attach to so subversive a conclusion—are not arteries at all, but veins tributary to the aorta; hence his recourse to the only other apparent source of blood supply to the heart muscle—the *ductus carnosi* of Vieussens, later known as *venae Thebesii.*[5]

In the revival of discussion, with persistent conflict of evidence,[6] as to the rôle of these channels, both normal and vicarious, the contention of Swedenborg forms an appropriate background. It is pictured in his own words, as follows: "For these ducts are so many small and proper arteries of the heart, and have their own small and proper ventricles or chambers, which we have denominated lacunae" [the intertrabecular crypts].[7]

A recent editorialist[8] has drawn attention to the

[1] Gustav Retzius, *Verhandl. d. Anat. Gesellsch.*, 1903.

[2] Ramström, "Emanuel Swedenborg's Investigations in Natural Science," etc., Uppsala, 1910.

[3] Nordenskiöld, "The History of Biology," transl. by Eyre, N. Y. and Lond., 1928.

[4] I owe my first information on the subject (1929) to the courtesy of Dr. John P. Sutherland, of Boston.

[5] The origin and development of Swedenborg's theory is discussed, with bibliographical notes, in the *Annals of Medical History*, N. S., 4: 434, 1932.

[6] For divergence of view *cf.* Wearn, *Jour. Exper. Med.*, 47: 293, 1928; Batson and Bellet, *Am. Heart Jour.*, 6: 206, 1930; Stella, *Jour. Physiol.*, 73: 36, 1931; 75: 18 P, 1932; Löhner, Pfl. Arch., 228: 457, 1931.

[7] "Œconomia Regni Animalis," Amster., 1740–48, I, 412. The extract follows Clissold's translation.

[8] *Jour. A. M. A.*, 98: 233, 1932.

marked discrepancies of result and inference on the Thebesian question as it concerns the possible compensatory function of these vessels in chronic coronary occlusion, and commendably emphasizes the urgent importance of having the problem settled with finality. In the future development of the subject Swedenborg's proposition may well find a place, historically, as embodying in principle one widely entertained hypothesis relative to the cardiac sinusoids. Even more, his almost modern structural conception of the intramural vascular relations, based on the injections of Lancisi and other eminent early anatomists, should have similar recognition.

FREDERICK H. PRATT
BOSTON UNIVERSITY SCHOOL OF MEDICINE
AND THE EVANS MEMORIAL,
MASSACHUSETTS MEMORIAL HOSPITALS

SUGGESTIONS IN STRATIGRAPHIC NOMENCLATURE

PERHAPS others as well as the writer have often been at a loss for a concise, logical and self-explanatory term for indicating all that portion of the geologic sequence (or geologic time) below or antedating the Cambrian system (or time). Strangely enough, the embarrassment becomes more acute if one searches for a term to include the Paleozoic, Mesozoic and Cenozoic. To the lower or earlier subdivision such terms as Azoic, Eozoic, Agnotozoic, Proterozoic, pre-Cambrian and pre-Paleozoic have been applied by various authors in different ways.[1] Chamberlin and Salisbury make a dual subdivision of this expanse of time into an Extrusive and a Gradational Eon, but in the latter they include the Proterozoic, as understood by them, and the basis is not "zoic," a feature so well fixed in geologic nomenclature since the days of John Phillips. Haug's treatise devoting one chapter to pre-Cambrian, the next to Cambrian, the next to Silurian, etc., does not clearly bring out the dual classification here under consideration. Ambiguities and needless circumlocutions are to be found in our most recent and authoritative writers on geologic topics owing to a lack of precise terminology.

Note the following:

> . . . the high degree of evolution and specialization seen in the invertebrate fossils at the very base of the Paleozoic was in itself a proof that pre-Paleozoic evolution occupied a period as long as or even longer than the post-Paleozoic.[2]

The meaning here is in doubt, but the chances are ten to one the author means post-Proterozoic, instead of "post-Paleozoic," else the whole Paleozoic is eliminated in his second time division. Again, p. 29, *op. cit.*

> The larger estimate of 80 million years on the theory that pre-Cambrian sediments took as much time as those from the base of the Cambrian upwards.

Bearing in mind the unique and overwhelming importance of life in the development of this planet and the still unexplained but universally recognized earlier moiety of geologic time, characterized by obscure traces of life, and a later moiety with life so abundantly preserved, one may perhaps denominate the earlier as the *Cryptozoic* and the latter as the *Phenozoic* Eon, unless more descriptive terms have already been suggested. Hence the above quotations would read:

> . . . the high degree of evolution and specialization seen in the invertebrate fossils at the very base of the Paleozoic was in itself a proof that Cryptozoic evolution occupied a period as long as or even longer than the Phenozoic."

> "The larger estimate of 80 million years on the theory that Cryptozoic sediments took as much time as Phenozoic."

Ambiguity, hyphenated hybrids and needless circumlocutions seem accordingly to be avoided.

G. D. HARRIS
PALEONTOLOGICAL LABORATORY
CORNELL UNIVERSITY

RUPTURED YOLK IN HENS AND PULLETS

SEVERE losses occur among chickens from a disease which sometimes results in the rupture of egg yolks in the abdominal cavity. Once established in a flock, the disease usually persists over a long period. In some flocks the death losses have amounted to more than 50 per cent. within a month.

In studies made on 87 flocks, *Pasteurella avicida* was recovered from 48 per cent. *Salmonella pullorum* and *Salmonella gallinarum* were found in a few cases.

Detailed studies were made on the pathogenicity of *Past. avicida* found in cultures and in tissues from field cases in eight flocks. Intramuscular and intraperitoneal injections of cultures and of yolk material from diseased birds caused death in from 18 hours to five days or longer. Infection sometimes occurred, following intranasal inoculation and when cultures were placed in drinking water. The introduction of cultures directly into the crop failed to produce infection. Lesions typical for the disease were produced in experimental birds and cultures of *Past. avicida* were recovered from most of the birds injected.

Post-mortem examinations of field cases and of experimental birds revealed the lesions usually described for fowl cholera. In addition to these lesions,

[1] See Gregory and Barrett, *Jour. Geol.*, 35: pp. 747–742.

[2] "Origin and Evolution of Life," 1930, p. 28.

definite changes usually occurred in the ovaries, and in many instances, ova ruptured and yolk material escaped into the abdominal cavity. The ovarian lesions were not found in those cases which developed septicemia and died very suddenly.

Ten healthy pullets were injected intraperitoneally with the entire yolk content of eggs laid by healthy hens. This was done in an effort to determine whether or not the possible rupture of a normal ovum would cause disease. The ten pullets failed to develop symptoms and autopsies on four revealed the fact that the injected yolk material was quickly absorbed.

H. A. HOFFMAN,
Pathologist

POULTRY PATHOLOGICAL LABORATORY
STATE DEPARTMENT OF AGRICULTURE
PETALUMA, CALIFORNIA

THE RÔLE OF BACTERIA AS FOOD FOR BOTTOM ANIMALS

IT has long been my opinion that we have not given bacteria sufficient credit for the part they play in the food supply of mud-flat and ocean-bottom animals.

Two Gephyrean worms of the species *Urechis caupo* Fisher and MacGinitie[1] were placed in rotted sea water and fed a culture of the bacterium *Pseudomonas* sp. for a period of 68 days. During this time these worms showed a growth which was greater than that usually occurring in nature. Two controls wasted away and died after 61 and 63 days, respectively.

Urechis caupo was used for this experiment, because it lives in mud-flat regions rich in bacteria and because it feeds by spinning a slime net, which intercepts all particles within the range of microscopic vision.

From the results of the above experiment it may be concluded that if a bottom animal can use a cultured bacterium as food and show normal or increased rate of growth, it seems safe to assume that when bacteria occur in the food of such animals in nature they are utilized in the proportion in which they occur.

The use of bacteria as a food supply offers possibilities for their use in rearing larvae for developmental studies and experimental embryology.

G. E. MACGINITIE

HOPKINS MARINE STATION
OF STANFORD UNIVERSITY

SCIENTIFIC BOOKS

Wild Beasts To-day. By HAROLD J. SHEPSTONE.

I WAS constrained, not long since, to buy a book called, "Wild Beasts To-day" by Harold J. Shepstone, largely because it was an English book and because it had been well reviewed. English writers on natural history have, in the past, set for themselves a splendid standard, and I for one have for years been buying books on wild life by British writers with a sure confidence that an evening's reading would be a real pleasure. The tendency, so obvious on the part of some American writers, to capitalize at a high advertising value facts which are unknown to the average reader, though well known to scientific persons familiar with the literature of their profession—this tendency has been conspicuously absent in the case of English writers, and this has been no small factor in explaining the considerable sale in America of English books on popular natural history.

With this preamble I will now add a few observations on Shepstone's book.

It is thoroughly well made, light, type well chosen and with many excellent illustrations. Some chapters are well written, as that dealing with the London Zoo and Whipsnade, but the book at large so abounds in inaccuracies as to cause one to be bewildered that so great ignorance can exist in one who makes bold to write a book. We read (p. 69) the old, silly story that a twelve-foot alligator is from seventy-five to one hundred and fifty years old—it is more likely twenty. The author speaks of his friend Campbell controlling his unruly alligators "by means of a hypnotizing effect" (p. 78). We read of snapping turtle farms in Japan (p. 93), but the snapping turtle, by universal usage, is the American Chelydra. These Japanese turtles can also bite through a stout cane or bite off the blade of an oar (p. 85), which, of course, is pure nonsense. The fact that the blow of a green turtle's fin will break a man's leg (p. 87) will be a surprise to those who have handled green turtles. The famous snake farm at Butantan in Brazil is a serotherapeutic, not serotherapic, institute, as Mr. Shepstone repeatedly calls it (p. 91). On p. 95 we read that snake venom has a high curative value in medicine, and it is declared to be a cure for epileptic fits as well as beneficial for rheumatism and certain cases of insanity. This will cause surprise and rejoicing in medical circles. There is a South African snake called a ringhals, but no ringhal (p. 96). So also there is a town in Arizona called Tucson (pronounced "Tooson"), but no town called Tuscan, nor do I know

[1] For a complete description of the feeding habits and natural history of this worm, see *Ann. and Mag. Nat. Hist.*, Ser. 10, Vol. 5, p. 204, July, 1930.

of any "extensive and well-conducted" lizard and snake farms there or anywhere else.

Ethnologists will be surprised to learn of Eskimos in northern Newfoundland, yet we read of Grenfell's buying reindeer for them (p. 139). I have two colleagues in the great Natural History Museum in New York, one Mr. John T. Nichols in the department of ichthyology and the other Dr. Robert Cushman Murphy, a curator in the department of birds. On p. 185 these gentlemen appear as the noted ichthyologists Professor J. T. Nicholas and Prof. R. Cushman-Murphy. The late lamented president of Stanford University was David Starr Jordan, not David Starr Johnson, and our author claims to have been to California, too! Further on an excellent picture of the beluga or white whale, quite the best I have ever seen, is labelled the "Peluga." There no doubt may be "Kelpspringers," but they are probably gammarid crustaceans; the animal our author wanted to discuss on p. 224 is called a klipspringer, and it knows not the kelp beds. I have the honor to belong to the Boone and Crockett Club in New York, but President Roosevelt never worked for wild life conservation with the Lewis and Clark Club, for there is none.

The thing, however, which has surprised me most was to learn that there are hundreds of eider ducks breeding on "Duck Lake off the coast of Maine." There is a colony of herring gulls and Leach's petrels on Duck Island off the coast of Maine, but there are positively no "lakes" off this coast at all.

Enough of this cavilling. The book abounds in inaccuracies. I think I have shown this to be the case. There is one other fault, which in truth is really harmful, and this is the amount of space and praise devoted to the transfer of bison from southern Canada into the northern wood bison reserve. This, one of the most tragic examples of bureaucratic stupidity in all history, was done against the protests of both Canadian and American naturalists who would rather have seen the surplus southern bison killed. They were known to be infected with bovine tuberculosis and they are certain to interbreed as well as infect the wood bison, which is a far finer animal and one of great zoological interest because in some respects it seems more like the European wisent than the common American bison. The book would have done well to have shown up this transfer to the public in its true light as a real tragedy and not as a triumph of conservation. The public as a matter of fact has never had the true story, and Shepstone might easily have given it as he could have gotten it from any intelligent mammalogist on this continent.

The writing of this review has not been a pleasure, and I only hope that British publishers will exercise more care in accepting manuscripts in the future. They have certainly set a most commendable example to their American confrères in the past—and one which the latter have often failed to follow.

THOMAS BARBOUR

HARVARD UNIVERSITY

A General Catalogue of the Radial Velocities of Stars, Nebulae and Clusters. By JOSEPH HAINES MOORE. xvi + 220 pp. Publications of the Lick Observatory, Vol. XVIII, 1932. University of California Press, Berkeley.

NEW catalogues of fundamental astronomical data, as they appear from time to time, bear witness to the rapid progress being made by observatories in many parts of the world in the accumulation of these data. The latest catalogue of sidereal radial velocities comes appropriately from the Lick Observatory, where investigations of the radial velocities of the stars have for many years constituted an important part of the programs, on Mount Hamilton and, until recently, at the southern station in Chile; and it comes from the hand of Dr. J. H. Moore, who has had a prominent share in these investigations.

The catalogue contains all stellar radial velocities published prior to January 1, 1932. It is complete for all stars down to visual magnitude 5.5, and contains in addition the radial velocities of many fainter stars, especially those in the northern celestial hemisphere. This unbalanced condition for the fainter stars will become increasingly serious, as Commission 30 of the International Astronomical Union has pointed out, unless the spectroscopic work can be more evenly distributed between the two hemispheres than it is at present. The number of stars entered in the catalogue is 6,739, counting the components of visual doubles as two stars, and of these 1,320 are considered to have variable velocities. For each star we find, among other data, the designation, position, visual magnitude, spectral class, mean observed radial velocity, usually to the tenth of a km./sec., and the adopted radial velocity, together with an estimate of its uncertainty. These radial velocities were determined at 19 observatories. The results derived at each observatory have been corrected for systematic differences, so far as possible, from the Lick system, which represents very closely the average for all.

Reference is made in the introduction to two previous catalogues of radial velocities published by Voûte, in 1921 and 1928. The reviewer would mention Schlesinger's "Catalogue of Bright Stars" also. This useful catalogue contains, together with other data, the radial velocities of all stars brighter than 6.5 visual magnitude which were known in June, 1930. These velocities are given to the nearest km./sec., and are reduced to the Lick system.

In addition to the stellar radial velocities the new catalogue lists the radial velocities of 133 galactic nebulae, including 18 in the Magellanic Clouds, the radial velocities of 18 globular clusters, and the radial velocities of 90 extra-galactic nebulae, assuming that the observed displacements of the lines in the spectra of these objects arise from the relative motions of nebulae and observer. Seven of these nebulae have relative velocities of approach. For the remainder the celebrated "red shift" predominates. The greatest velocity of recession at the date of closing of the catalogue is 19,700 km./sec. The catalogue gives evidence of the greatest care in the assembling and arrangement of the material, and in the printing. It is a valuable contribution to the literature of astronomy.

ROBERT H. BAKER
UNIVERSITY OF ILLINOIS OBSERVATORY

REPORTS

THE ASSOCIATION TO AID SCIENTIFIC RESEARCH BY WOMEN

SINCE the final meeting of the Association to Aid Scientific Research in New York on Saturday, April the thirtieth, the secretary has received many requests for information about the association. It seems fitting, therefore, that SCIENCE print for the benefit of its readers this brief sketch of the whys, wherefores, origin and termination of the Association to Aid Scientific Research by Women.

To go back many years, in 1872 Professor Anton Dohrn founded at Naples, Italy, a Zoological Station for the collection of biological material and for the study of various forms of plant and animal life. This station rapidly developed into an institution of international importance, where students gathered from all over the world for scientific research and professional training as teachers of science. Among those who had studied at the station was Miss Ida H. Hyde, an American woman, who received her doctor's degree from the University of Heidelberg in 1896. It occurred to Miss Hyde that it would be eminently fitting for those interested in the scientific training of women to establish and maintain at Naples a table for the use of qualified American women who might wish to avail themselves of its opportunities for scientific research. This thought became definite when at the twenty-fifth anniversary of the founding of the Zoological Station in 1897, Dr. Dohrn asked for a permanent endowment fund and suggested that it take the form of endowed tables of research; each table to cost $500 per annum and to be supplied by the station for this fee with materials for research and with service, the maintaining organization to have the privilege of assigning the table.

Shortly after the meeting, therefore, Miss Hyde proposed to establish an American Women's Table at Naples in recognition of the unfailing kindness and cooperation shown from the outset and at all times by Dr. Dohrn in according to women the privileges of the station upon equal terms with men.

Upon her return to America, Miss Hyde found many ready and eager to cooperate with her in the plan, not solely because of interest in the Zoological Station, but because of their desire to encourage young women in scientific research.

A committee was formed in the autumn of 1897, and a circular describing the place and asking for contributions was sent out by the following sponsors: Miss M. Carey Thomas, president of Bryn Mawr College, *chairman;* Miss Ida H. Hyde, Cornell University, *secretary;* Miss Louise Sheffield Brownell, warden of Sage College, Cornell University; Miss Florence M. Cushing, Vassar College; Miss Sarah E. Doyle, president of the Rhode Island Society for the Collegiate Education of Women; Miss Annie Crosby Emery, dean of women, University of Wisconsin; Miss Julia J. Irvine, president of Wellesley College; Miss Agnes Irwin, dean of Radcliffe College; Dr. Eliza M. Mosher, dean of women in the department of literature, science and the arts, University of Michigan; Mrs. Alice Freeman Palmer, president of the Women's Education Association of Boston; Mrs. Alice Upton Pearmain, president of the Association of Collegiate Alumnae; Mrs. Ellen H. Richards, Massachusetts Institute of Technology; Miss Emily James Smith, dean of Barnard College; Miss Marion Talbot, dean of women, University of Chicago.

As a result of the circulars a meeting was held in Cambridge on April 14, 1898, and an organization, called at that time the Association for Maintaining the American Women's Table at the Zoological Station at Naples, was formed (several years later the name was changed to the Association to Aid Scientific Research by Women). As a result of this Cambridge meeting subscriptions of fifty dollars each were reported as having been received from the Association of Collegiate Alumnae, Bryn Mawr College, the Massachusetts Institute of Technology, Radcliffe College, Sage College of Cornell University, Smith, Wellesley and Vassar Colleges, the Committee on Science Lessons of the Women's Education Association of Boston, the Women's College of Baltimore, from Miss Lillian

V. Sampson, of Germantown, and Mrs. John Wescott, of Princeton, and a draft for $500 was sent to Dr. Dohrn at Naples to maintain the American Women's Table at the Naples Station for the year 1898–99.

From its inception there was a balance in the treasury of the association over and above the $500 paid yearly for the upkeep of the Naples Table, and for a time the association voted this in the form of grants to scholars working at the table. This plan was abandoned later in favor of the final policy of the association, which was to permit the surplus to accumulate until sufficient in amount to offer as a prize of encouragement for scientific research by women and ultimately, as a recognition of work accomplished. Thus, the Ellen Richards Research Prize, with a value of $1,000, was established. This prize has been offered fourteen times, and has been awarded six times as follows: Dr. Florence Rena Sabin (U. S. A.); Dr. Nettie M. Stevens (U. S. A.); Dr. Florence Buchanan (England); Dr. Ida Smedley McLane (England); Dr. Eleanor Carothers (U. S. A.); Dr. Evelyn Laing (England). Later this prize was increased to $2,000 and awarded to Madame Curie in 1921, and the 1928 $2,000 prize was divided equally between Dr. Lisa Meitner, of the University of Berlin, and Dr. Ramert-Lucas, of the University of Paris.

Throughout the thirty-five years of its existence, the Association to Aid Scientific Research by Women was maintained by annual subscriptions of fifty dollars each. It met annually each April, by invitation from different members. Any institution, association, group of individuals or individual who subscribed fifty dollars annually might be elected to membership in the association during the continuance of the subscription. Each membership could nominate a voting representative to attend the annual April meeting. Its purpose has been to maintain a table for the use of women at the Zoological Station at Naples, and to encourage and recognize, through its Ellen Richards Research Prize, successful achievement in scientific research by women.

As the guests of Dr. Florence R. Sabin at the American Woman's Club in New York on Saturday, April 30, twelve members of the Association to Aid Scientific Research by Women met to make the final award of the Ellen Richards Research Prize. The decision was a most difficult one, so again, as in 1928, the $2,000 prize was equally divided, this time between the two distinguished American scholars, Dr. Helen Dean King, the biologist of the Wistar Institute, University of Pennsylvania, and Dr. Annie Jump Cannon, the astronomer of the Harvard Observatory, Cambridge.

There being no further business, the following resolution, drafted by Dean Nicolson, of Smith College, President Pendleton, of Wellesley, and Dean Gildersleeve, of Barnard, was presented and carried:

Whereas, the objects for which this Association has worked for thirty-five years have been achieved, since women are given opportunities to engage in Scientific Research on an equality with men, and to gain recognition for their achievements, be it

Resolved, that this Association cease to exist after the adjournment of this meeting.

And thus, with the adjournment of the meeting, the Association to Aid Scientific Research by Women ceased to exist as an active organization. In the minds of those who have had the great happiness of attending its meetings and sharing in its activities, the association shall long live as one that has played a really vital part in the advancement of scientific research by women.

H. JEAN CRAWFORD,
Secretary
UNIVERSITY OF PENNSYLVANIA

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MEDICAL SCIENCES AT ATLANTIC CITY

THE program for Section N (Medical Sciences) at Atlantic City is practically complete. It will be devoted entirely to symposia on timely subjects of medical interest.

Dr. John J. Abel, president of the association, will lead a very important symposium on "The Present Knowledge of the Hypophysis Cerebri (Pituitary Body)," on Wednesday afternoon, December 28. Dr. Herbert M. Evans, of the University of California, will participate in this symposium by discussing the hormones of the anterior hypophysis. In presenting a paper on the pituitary-gonad relationship, Dr. Philip E. Smith, of the College of Physicians and Surgeons, Columbia University, will point out the importance of the receptor organ and the method of administration of extracts. Dr. E. M. K. Geiling, of the Johns Hopkins University, will describe the functions of the posterior lobe of the pituitary body. Dr. George W. Corner, of the University of Rochester, Dr. Harvey W. Cushing, of Harvard University, and Dr. John J. Abel will take part in the discussions.

Dr. Wm. H. Park, chairman of Section N, has organized a symposium on tuberculosis for Wednesday

morning. At this session, Dr. Eugene L. Opie, of Cornell University Medical School, will discuss spontaneous immunization in tuberculosis. Dr. Camille Kereszturi, of the Department of Health, New York City, will consider the fate of the new-born in a tuberculosis home with and without vaccination, and Dr. Lucy Mishulow, of the Department of Health, New York City, will describe preliminary isolation and differentiation of the tuberculosis bacilli on Bordet, Gengou and Lowenstein media.

Important sessions for discussions of filterable viruses and filterable virus diseases have been arranged for Thursday, December 29. Dr. Wm. H. Park will present a paper on the epidemiology, prevention and treatment of poliomyelitis (infantile paralysis). Dr. Edmund V. Cowdry, of Washington University, will discuss nuclear inclusions in virus diseases. Dr. Roscoe R. Hyde, of the Johns Hopkins University, will consider problems presented in the study of filterable viruses, and Dr. Earl B. McKinley, of George Washington University, will discuss filterable virus diseases and the nature of their causative agents. Dr. Max Theiler, of the Rockefeller Foundation, will discuss the susceptibility of common laboratory animals to the virus of yellow fever, and Dr. Thomas M. Rivers, of the Rockefeller Institute, will explain the nature of viruses and the pathology of virus diseases in relation to serum therapy. Dr. Hans Zinsser, of Harvard University, will lead the general discussion.

A joint session of Section L (Historical and Philological Sciences), Section N, the History of Science Society and the American College of Dentists will be held on Thursday evening. Dr. Wm. H. Welch, of the Johns Hopkins University, will preside at this session and present a paper entitled, "Antony van Leeuwenhoek: A Tribute on the Tercentenary of His Birth." The retiring chairman of Section N, Dr. Howard T. Karsner, of Western Reserve University, will give an address on "Medieval Guilds of Medical Interest." Following Dr. Karsner's address, Dr. Henry E. Sigerist, of the Johns Hopkins University, will discuss "The Edwin Smith Surgical Papyrus." Dr. Harvey W. Cushing, of Harvard University, will present a paper entitled "The Anatomical Tables of Ercole Lelli."

On Friday, all day, Section N will hold joint sessions with the American College of Dentists for the reading of invited papers that will show phases of dental science having particular interest for medical men. The chairmen at the morning and afternoon sessions will be Dr. Arthur D. Black, of Northwestern University, and Dr. L. M. Waugh, of Columbia University, respectively. Dr. F. S. McKay, formerly associated with the U. S. Public Health Service, will describe the sequence of scientific observations that led to the discovery of the cause and prevention of mottled enamel. Mottled enamel is a seriously destructive condition in various districts, in Arizona, Arkansas, Colorado and Idaho, especially. Dr. McKay will report that this condition has recently been found to be due to excessive amounts of fluoride in drinking water and will emphasize the importance of measures for its prevention. Dr. Theodor Rosebury, of the College of Physicians and Surgeons, Columbia University, will speak on the experimental production of typical dental caries in animals and its value for the study of decay of teeth in man. Dr. J. J. Enright, of the Mellon Institute, will lead the discussion of Dr. Rosebury's paper. Dr. J. L. T. Appleton, Jr., of the University of Pennsylvania, will discuss the scientific treatment of teeth having infection at their roots. Dr. V. H. Kazanjian, of Harvard University, will present a paper on problems in oral surgery as affecting reconstruction of face and jaws. Dr. Robert H. Ivy, of Philadelphia, will lead the discussion of Dr. Kazanjian's paper. On Friday afternoon Dr. Frederick B. Noyes, of the University of Illinois College of Dentistry, will speak on the advisability of converting orthodontia into a specialty of medical practice. Dr. Milo Hellman, of the American Museum of Natural History, will lead the discussion of Dr. Noyes' paper. Dr. Wilmer Souder, of the U. S. Bureau of Standards, will point out how science aids in improving dental restorations. Dr. W. W. Wright, of the University of Pittsburgh, will discuss morphological changes in the mucous membrane covering edentulous areas of the alveolar process in the human mouth.

At 4:45 P. M., Friday, Dr. R. W. Bunting, of the University of Michigan, director there of the dental research supported by the Couzens Children's Fund, will give an address on recent developments in the study of dental caries (decay). This address, which will be delivered at a general session of the association, will be of interest to every one.

A dinner for members of the American College of Dentists and of Section N, and their guests, will be held on Friday evening. Following the dinner, Dr U. G. Rickert, of the University of Michigan, retiring president of the college, will deliver an address on the present status of dental research. After the address of Dr. Rickert, Dr. Weston A. Price, of Cleveland, will speak on "New Light on the Cause and Control of Tooth Decay in Man, from Field Studies of Primitive Districts Providing Immunity."

A number of papers, which will be given at meetings of the American Society of Parasitologists, will be of special interest to medical men. In particular

Dr. G. F. White, of the U. S. Bureau of Entomology, will present a paper on the production of sterile maggots for surgical use. Dr. G. F. Otts and Dr. W. W. Cort, of the Johns Hopkins University, will speak on post-treatment infestation with Ascaris and hookworm. Other papers of distinct medical interest will be presented by Dr. R. B. H. Gradwohl, of St. Louis, Dr. E. C. Nelson, of the Johns Hopkins University, Dr. Ernest C. Faust, of Tulane University, and Dr. R. W. Glasser, of the Rockefeller Institute for Medical Research. A total of 76 papers will be presented at sessions of the American Society of Parasitologists.

CHARLES F. ROOS,
Permanent Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A RELIABLE METHOD FOR THE PRODUCTION OF NUTRITIONAL ANEMIA IN WHITE RATS

IN the production of experimental anemia in albino rats fresh cows' milk is widely used as the sole ingredient of the diet. This ability of fresh cows' milk to produce anemia is evidently dependent on its copper and iron components. In our experience it has been difficult to produce a uniform degree of anemia at the end of a given period of time. This has been due in no small measure to the fact that the iron and copper content of cows' milk varies with the breed of the cow, the diet of the cow, the season of the year (doubtlessly involving the diet) and the method used in collecting and storing the milk. When the fresh milk diet is used the milk rapidly sours in feeding jars and must, on that account, be given in several small doses daily. With such variations and inconveniences it has frequently been necessary to maintain the animals on the fresh milk diet for several months before a severe anemia developed. Because of these difficulties in obtaining consistent anemia in albino rats on the whole milk diet another form of milk has been tested in this laboratory. Klim, a whole dried milk, when fed as such, has caused the development of a severe anemia in albino rats much more consistently than the fresh milk diet. Water was given the animals in a separate container *ad libitum*. The Dryco brand of dried whole milk has not yet been used, for Supplee *et al.*[1] have reported that it does not support the production of anemia.

The mortality among the rats on the Klim diet, in our experience, has been much lower than with the fresh milk ration. The variation in the extent of anemia produced in the animals at the end of a given period of time was less. At the end of four weeks on the diet a typical group of 25 animals showed a maximum hemoglobin content of 3.8, a minimum of 2.5, and a mean of 3.1 grams of hemoglobin per 100 cc of blood. It has been found that occasionally a rat will grow much more rapidly than his fellows in a test. At the same time there is a more rapid decrease in the blood hemoglobin value of this rat with the result that at the end of four weeks there are but 1.8 grams per 100 cc of blood. These occasional exceptions have been discarded from the tests.

The growth of the animals on this diet is rapid and uniform. During the first few days they generally develop a diarrhea (perhaps associated with high lactose intake) but this clears up before the seventh day and has no apparent effect on the curve of weight increase.

The 100 animals whose growth and hemoglobin curves are shown in Fig. 1 were fed the Klim diet

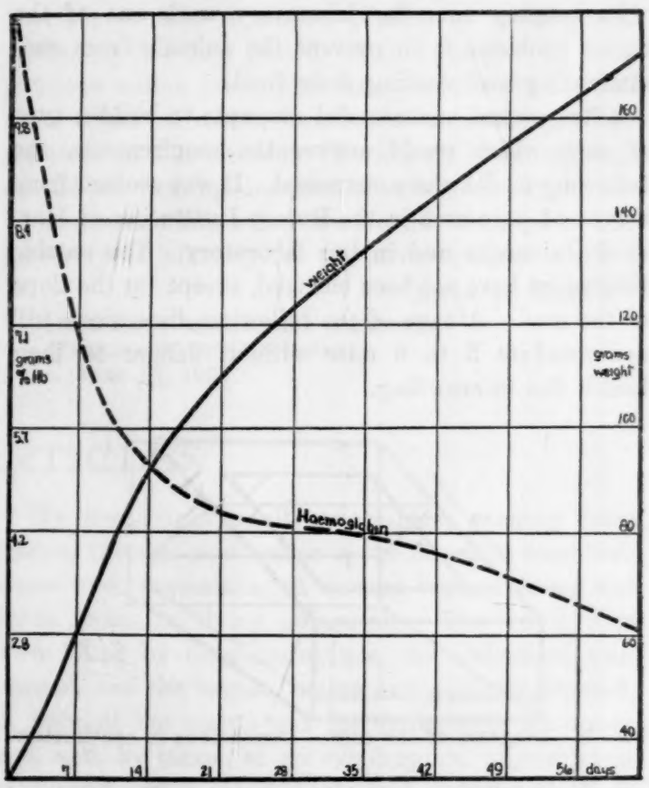

Figure 1

with no supplements. They were housed in heavily galvanized iron wire cages with false bottoms. They were not bred with the precautions recommended by Elvehjem and Kemmerer[2] nor caged in glass compartments,[3] for it appears that this is not necessary. It

[1] G. C. Supplee, O. D. Dow, G. E. Flanigan and O. J. Kahlenberg, *Jour. of Nutrition*, 2, 451, 1930.

[2] C. A. Elvehjem and A. R. Kemmerer, *Jour. Biol. Chem.*, 93, 189, 1931.

[3] (a) W. B. Nevens and D. D. Shaw, SCIENCE, 72, 249, 1930; (b) F. A. Underhill, J. M. Orten and R. C. Lewis, *Jour. Biol. Chem.*, 93, 13, 1931.

is possible that these additional precautions would have produced an even more severe anemia, however.

It was found that the three lots of Klim used in these tests contained about .00024 per cent. iron (standard colorimetric-thiocyanate method). No copper was detected in analyses which would detect one part of copper per million (pyridine-carbon tetrachloride-thiocyanate method). The amount of copper and iron in Klim will fluctuate, but the variation should be not nearly as extensive as it would be were small batches of fresh whole milk used, because a quantity of Klim may be purchased, stored and used in a series of single comparative tests, thereby eliminating the uncertainty which exists when the whole milk ration is used.

ROBERT S. HARRIS

DEPARTMENT OF BIOLOGY AND PUBLIC HEALTH
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A PRACTICAL TYPE OF MOUSE CAGE

IN keeping mice for laboratory work one of the major problems is to prevent the animals from contaminating and wasting their food.

After several unsuccessful attempts to build a type of cage which would answer the requirements, the following model was constructed. It was evolved from a type of cage used in the Bussey Institution of Harvard University and in this laboratory. The outside dimensions have not been changed, except for the slope of the roof. A cage of the following dimensions will accommodate 5 to 6 mice without danger to their health due to crowding.

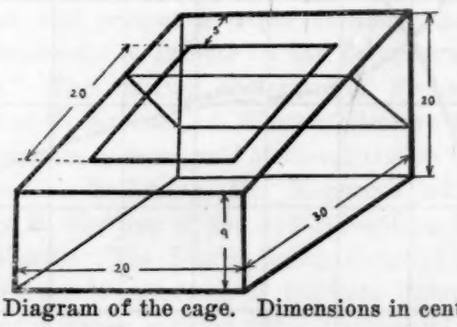

FIG. 1. Diagram of the cage. Dimensions in centimeters.

Floor space	20 × 30 cm
Front elevation	9 cm
Back elevation	20 cm
Door	15 × 20 cm
Food container	12 × 20 cm
Distance of the upper edge of the door to the upper edge of the food-rack	5 cm

The dimensions were chosen arbitrarily, but experience shows that they give the most satisfactory results. The door is kept in place by a flat water bottle. The 12 ounce water bottle has a perforated stopper through which runs a bent-glass-tube, the narrowed opening of which projects into the cage. The angle of the sloping roof is of importance; if the roof is made too steep the water runs out too fast and wets the sawdust on which the cage stands; if the slope is not sufficient, the hydrostatic pressure of the water in the bottle is not enough to permit the animals to drink.

The important new feature of the cage is the food container. It is made of wire netting of the same mesh as the cage itself (14 threads per decimeter). The food container may be filled with commercial "Dog Chow" or any other balanced ration in pieces of appropriate size (about 2 cm in diameter). The animals have no difficulty in eating through the meshes of the wire netting of the food rack. The food container is inclined to the back of the cage at an angle of about 45 degrees. The mice will eat with their heads upward and are forced to adopt a position which makes contamination of the food with urine or feces impossible. There is a considerable saving in food as there is no waste from spoiled food.

The door is arranged in such a way that it closes both the entrance to the cage proper and the food rack. Therefore the food will not spill when the cage is tipped to permit cleaning the bottom. The food rack may be filled once a week. The cost of constructing such a cage is not much higher than that of any other of the same material, while it saves much labor and safeguards the health of the animals, especially of the young, by preventing the consumption of contaminated food.

The model may be used for rats by adjusting the dimensions. For rats, wire mesh should be used which has 8 threads per decimeter.

This cage has been in use in this laboratory for a year and is found entirely satisfactory.

ERNST ENZMANN

LABORATORY OF GENERAL PHYSIOLOGY
HARVARD UNIVERSITY

MODIFIED HANGING DROP TECHNIQUE

IN the course of studies of the growth characteristics of molds, the writer found the normal hanging drop culture unsatisfactory because, with this technique, in a majority of cases the hyphae grow towards or on the spherical surface of the drop and only short sections can be brought into focus in any one field. In order to overcome this difficulty, the mold is grown in a thin film of medium which can be placed perpendicular to the axis of the microscope and thus the entire lengths of the hyphae in the field remain in

focus. This type of hanging drop culture is described below.

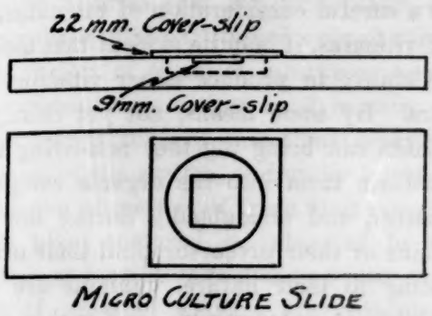

FIG. 1

A suspension of mold spores is made in any suitable liquid culture medium. A small drop of this suspension is transferred with an inoculating loop to the center of a 22 mm cover-slip. On top of the drop is placed a 9 mm cover-slip, easily made by quartering an 18 mm slip. The large cover-slip, carrying the smaller one, is then inverted and placed over the hollow chamber of a micro culture slide and the edges sealed with petrolatum to prevent evaporation of the medium. The smaller cover-slip is held firmly by the surface tension of the film of medium. Two views of the culture slide are shown in the accompanying diagram.

This technique has proved very satisfactory for the observation of growing molds over relatively long periods of time. With practice one can obtain films containing few or many spores at the start, depending upon the density of the original inoculation and the size of the drop used. The size of the drop also determines the thickness of the film which can be varied from 5 to 40 microns. If care is used in cleaning the cover-slips, uniform films free of air bubbles can easily be obtained. If desired the entire operation can be carried out aseptically.

If a hollow chamber about 15 mm in diameter and 3 mm deep is used, there appears to be enough oxygen present to support normal growth of the spores near the edge of the smaller cover-slip. Spores near the center of the smaller cover-slip at times fail to germinate, probably because of the lack of sufficient free oxygen. Since the total amount of medium present is relatively small for the amount of growth which takes place, the supply of foodstuff is more quickly exhausted and concentration of the waste products increases more rapidly than in the normal test tube or plate culture. Only the vegetative hyphae of such molds as the Penicillia and Aspergilli remain in the film of medium; the fertile hyphae grow in the air at the edge of the small cover-slip.

By the use of this type of culture, it has been possible to take a motion picture of mold growth during a five-day period. Rapid motion of small granules within the hyphae has been observed. With some types of molds, immiscible metabolic products separate in the medium. Variations in morphology caused by varying amounts of available oxygen can be observed. The writer has found this type of culture very satisfactory for photomicrographic work.

IRVIN H. BLANK

DEPARTMENT OF LEATHER RESEARCH,
UNIVERSITY OF CINCINNATI
June 14, 1932

SPECIAL ARTICLES

THE ORIGIN OF THE CELLULAR DEBRIS IN VAGINAL SMEARS OF THE GUINEA-PIG

THE mammalian vaginal discharge ordinarily contains at some time or other in the oestrus cycle large and small non-cornified epithelial cells, large cornified epithelial cells, leucocytes (mainly polymorphonuclear), erythrocytes and mucus. It is generally known that the leucocytes reach the vaginal lumen by diapedesis through its epithelial lining and that the large non-cornified and cornified cells are sloughed from its epithelium. There has also been every reason to believe that the erythrocytes come from mucosal hemorrhages of the uterus, and possibly in some cases by way of the oviduct, following the rupture of the ovarian follicles. The only cell type over which there seems to be much question is the small non-cornified epithelial cells which often occur in clumps or sheets in the vaginal secretions. These have been assumed to be of uterine origin.

We used eight adult guinea-pigs, ranging from oestrus through postoestrus to the dioestrus condition. None were prooestrus. A normal vaginal smear was made from the living guinea-pig. The animal was then killed by illuminating gas, the abdominal wall opened, and the vagina, uterus and oviducts exposed. A horn of the uterus was cut across near its upper end, and, by means of an eye-dropper, physiological saline was gently injected into and sucked back from the uterus above the section. A drop of this was allowed to evaporate on a slide. Another transverse cut was made below the previous one and the process repeated, the discharge again being obtained from that part of the uterus above the section. Smears were thus made from the uterine cornu, uterine fundus, the vagina near the cervix and the vagina. Since, however, no differences were observed in smears taken in different parts of the uterus, or in smears taken in different parts of the vagina, we continued to make

smears only of the uterine cornu, uterine fundus and vagina.

Cornified epithelium was found in the normal control vaginal smears of the living. In all these animals after death cornified epithelium was found in smears of the vagina as high as the cervix, and was invariably absent above the cervix. Except in animals that were in oestrus, large non-cornified epithelial cells were found in vaginal smears before and after killing. In no cases did we obtain large non-cornified epithelial cells in the uterus. Small non-cornified epithelial cells were found throughout the genital system in those animals not in heat. Clumps of small non-cornified epithelial cells, such as observers have noticed in normal external vaginal smears, were found in the uteri of all. Polymorphonuclear leucocytes were found abundantly in both uterus and vagina in those animals not in oestrus, whereas those in heat showed none in the vagina and a decreased number in the uterus. Mucus occurred in both uterus and vagina, in several cases being more abundant in the uterus. Some erythrocytes were present in all smears taken after cutting open the tract, and were therefore assumed to be due to unavoidable contamination resulting from the cutting.

Before drawing any conclusions, it is well to keep in mind that we used only eight animals and that only a rough quantitative estimate of the cells was made, so no attempt to point out cyclic variations is justified. Furthermore, the method allowed the accurate determination of the *highest* origin of a constituent only. For instance, we found leucocytes in both the uterus and vagina. We can say with reasonable certainty that they do arise in the uterus, but our only indication that they arise in the vagina is their greater abundance there. Of course from the work of others where sections of the vagina have been made, it has been clearly demonstrated that they do arise in large quantities in the vagina by diapedesis. Then, too, there is a possibility that the oviducts contribute to the débris. The oviducts of the guinea-pig are very slender; their products, if any, must be very slight in amount, so we feel justified in disregarding them.

In the guinea-pig, then, the origin of the large non-cornified and cornified epithelial cells is the vagina. Small non-cornified epithelial cells, often in clumps and sheets, come from the uterus. Leucocytes arise in considerable quantities from the uterus as well as from the vagina. Mucus also arises mainly in the uterus, but of course may possibly also come from the vagina.

BERNARD FRIEDMAN
JUDAH ZIZMOR

ANATOMY DEPARTMENT,
UNIVERSITY OF WISCONSIN

AVAILABILITY OF VITAMINS IN PLANT TISSUES[1]

AFTER a careful consideration of the natural occurrences of vitamins, it is quite evident that most plants have the ability to produce either vitamins or their precursors. By some means, not yet clearly understood, plants can bring together non-living materials and transform them into the organic compounds of living matter, and undoubtedly during this process, the vitamins or their precursors find their origin.

According to their nature, vitamins are classified as fat-soluble or water-soluble, and within each class are found several individuals. When these vitamins are produced by plants, each species of plant is genetically capable of establishing certain individual vitamins within its tissues. However, the quantity, potency or available amount of a certain vitamin in a plant of a given species is not always uniform. This appears to vary with the variety[2] of the plant, its degree of maturity or the conditions of soil and climate under which it grew, and with seasonal differences.

After the plant produces its vitamins, either for self-defense and protection, or to serve as hormone-like regulators, it stores them in its tissues. They appear to be kept within the plant cell. Carotene, now recognized as a precursor of vitamin A, has already been associated with the chloroplasts of the cell.[3] The occurrence of droplets of fat in the cytoplasm offers a location for fat-soluble vitamins, or they may be connected with the lipoids, that seem to possess great significance in the activity of the cell, by forming thin films at the interfaces between the continuous and disperse phases. As for water-soluble vitamins, they undoubtedly would be found in the watery sap that fills the vacuoles, or in the aqueous part of the cytoplasm of the cell.

Not all the plant cells, however, are equally supplied with vitamins. In some cases, vitamins seem to be stored in that portion of the plant most exposed to sunshine.[4] House[5] and associates have also found the periderm of the carrot root to be a better source of its vitamins than the cortex.

If the cytoplasm of the plant cell is then recognized as the place where the vitamins are located, their

[1] Contribution from Montana State College, Agricultural Experiment Station, Paper No. 18, Journal Series.

[2] M. F. Bracewell, E. Hoyle and S. S. Zilva, *Biochem. Jour.*, 24: 82–90, 1930.

[3] L. S. Palmer, "Carotinoids and Related Pigments," American Chemical Society Monograph No. 9, Chemical Catalog Co., Inc., New York, 1922.

[4] V. C. Heller and R. R. St. John, *Jour. Nutr.*, 4: 227–33, 1931.

[5] M. C. House, P. M. Nelson and E. S. Haber, Research Bulletin No. 120, 1930, Iowa Agricultural Experiment Station, Ames.

availability to the consuming animal will depend to a considerable extent upon the condition of the cell itself. Sharp[6] believes that the protoplasm of the cell is a polyphase, film-partitioned organization and that a great variety of chemical substances coexist in protoplasm without interacting until certain conditions prevail. It is thought that films separate the different phases of the system, and under appropriate circumstances the properties of these films are altered.

When the plant material is subjected to varied treatment, such as long storage during winter months, or the heat of cooking, changes are recognized as occurring in the organization of the plant cells. In the former case, enzymic activity, and in the latter, coagulation, may cause alterations in viscosity, permeability and rate of oxidation.

It has seemed to the authors that the above conception of the placement of vitamins in the plant cell, together with a variation in their degree of availability, depending upon the condition of the cell, would greatly assist in the interpretation of results obtained in vitamin studies, not only of those conducted in our own laboratory but those reported by other workers.

For five years, the home economics department of the Montana Experiment Station has been testing the Netted Gem variety of potato for its vitamin B (complex) and C potency. The tests have been made under the following conditions: Mature potatoes in the fall (a) raw, (b) boiled twenty-five minutes; potatoes stored six months in cool, damp cellar (c) raw, (d) boiled as above; potatoes stored six months in warm, dry cellar, (e) raw, (f) boiled as above.

Similarly, Chantenay carrots have been tested during four years for their vitamin A, B_1 and C potency, under the same conditions as noted for potatoes. In addition, the carrots have been subjected to home canning, by the hot-pack method, in both the oven and the steam pressure cooker.

When the results of these feeding experiments (to be published later) are summarized, the general changes in the vitamin potency of carrots and potatoes may be presented by means of a system of numerical grading shown in the following chart. As tests for vitamin C potency consisted not only in observations of protection from scurvy but also of gains in weight, and as these did not always show parallel agreement, we have separated these observations under two headings C_s (vitamin C as a protector from scurvy) and C_g (vitamin C as effective in growth).

It will be noted at once that the same method of treatment may result in no change, a gain or a loss

[6] L. W. Sharp, "Introduction to Cytology," Ed. 2, 214–222, 1926.

CHANGES IN POTENCY OF VITAMINS IN PLANT TISSUES, AS DETERMINED BY ANIMAL-FEEDING EXPERIMENTS, AND EXPRESSED BY NUMERICAL GRADING.

Conditions when tested	Carrots A	Carrots B_1	Carrots C_s	Carrots C_g	Potatoes B	Potatoes C_s	Potatoes C_g
Fall							
Raw	1.0*	1.0	1.0	1.0	1.0	1.0	1.0
Boiled	0.8	0.8	1.05	1.0	1.0	1.0	1.0
Spring							
1. Cool, damp storage	4 mos.				6 mos.		
Raw	1.0	1.0	1.2	1.1	1.0	1.0	1.1
Boiled	1.1	0.8	0.9	1.2	0.8	0.9	1.1
2. Warm, dry storage	4 mos.				6 mos.		
Raw	1.0	1.0	1.3	1.2	1.0	1.2	1.2
Boiled	1.1	0.8	0.8	0.8	0.8	0.9	1.1
Fall							
Canned							
in Oven	1.0	1.0	0.5	0.4			
in Pr. Cooker	1.0	0.9	0.6	0.6			
Spring							
Canned and kept 6 mos.							
in Oven	0.8	0.5	0.3	0.3			
in Pr. Cooker	0.8	0.5	0.4	0.4			

1.0* = initial potency.

of potency in the several factors here considered. Due to this lack of uniformity of effect upon the vitamins, each will be discussed individually in an attempt to interpret the above trends.

VITAMIN A

This vitamin is now recognized as occurring in the form of its precursor, carotene, when in plant tissue. In the carrot root, carotene is associated with fatty substances in the chromoplasts of the cell. When equivalent amounts of carrot are ingested in a raw form, apparently equal amounts of vitamin A are available to the consuming animal, irrespective of whether the carrot has just reached fall maturity or has been stored in various ways for four months. A comparison of the vitamin A potency of cooked carrots, in the fall and after storage, presents a different picture. While the cooked carrots, tested in the fall, appear to have suffered a loss in potency as compared with raw carrots, the authors believe that may be attributed to some change in the condition of the chromoplasts that has rendered the vitamin A less available. This conclusion was reached after finding that cooked carrots from cool or warm storage showed a gain in potency. This latter phenomenon is explainable on the basis of greater availability of vitamin A from the chromoplasts of the cells. Cold

and warm storage are known to bring about transformations in the cell structure of plant tissue that might result in changes at the interfaces concerned, thereby increasing the permeability of the chromoplasts when exposed to short cooking.

Canning, on the other hand, subjected the carrots to higher temperatures for a longer period of time, which might readily have caused a weakening in the boundary films of the chromoplasts. When tested for vitamin A in the fall immediately after canning, its availability was comparable to raw carrot but was greater than that of carrots cooked for only a short period. When these canned carrots were kept for six months and then tested, they showed a decided loss in vitamin A potency, that might be due to greater susceptibility to oxidation resulting from greater availability after canning.

Vitamin B (Complex) and B_1

Vitamin B_1, in its simple or complex form, is water-soluble and, as previously mentioned, undoubtedly resides in the aqueous part of the cytoplasm of the cells. When either potato or carrot is ingested in a raw form, at the point of maturity in the fall or after warm and cool storage, vitamins B_1 or B (complex) appear to be available to a maximum degree. After boiling for 25 minutes, however, there is a distinct loss in the potency of these vitamins, with the exception of potatoes in the fall. This change in potency might again be explained as due to changes in cell conditions that permit the release of the solution of vitamin B and its ready oxidation before being ingested. During the canning process, vitamin B_1 in carrots undergoes a slight loss in potency in the pressure cooker, but no loss when canned in the oven. When the canned carrots were again tested in the spring, they showed a pronounced loss in potency. This might be attributed to oxidation of the vitamin after it is made more available by the canning process.

Vitamin C

This vitamin is also water-soluble, and for this reason may be regarded as occurring in the aqueous part of the cell. Results from our animal feeding experiments indicate that the vitamin C potency of raw carrot increases during either cool or warm storage. This increase is greater, however, in carrots from warm storage. Because of this evident increase, the authors believe that the total amount of vitamin C present in the raw fall carrot is not available to the consuming animal. It is again assumed that during storage cellular changes occur, which render the vitamin C in the carrot available to a greater degree, especially when stored in a warm, dry cellar. The fall carrot, when cooked for a short period, offers slightly more protection from scurvy than it did in the raw form. It would seem then as if cooking produced some changes that also made vitamin C somewhat more available. Tests made on stored carrots when cooked show, on the other hand, some loss of vitamin C in the case of cool storage, and definite loss in warm storage. As the tests of raw carrot from these storages indicate a greater availability of vitamin C, it is apparent that this vitamin has become more susceptible to oxidation during cooking. This point is more strongly emphasized in the pronounced progressive loss of vitamin C potency in canned carrots that were kept for six months.

The preceding summary of a five-year study of the vitamin C potency of potatoes, before and after storage, shows some agreement with the results of the carrot investigations. Again there is an increase in vitamin C potency in the raw potatoes from warm storage, which suggests greater availability. Also, as in carrot, there is greater loss of vitamin C potency in stored potatoes after cooking than in the fall, indicating susceptibility to oxidation.

It is interesting to note the data on animal growth (C_ϵ) that were observed while testing the anti-scorbutic potency of potatoes and carrots. Their variations do not always coincide, but again there appears to be an increase in the growth tendency after storage, which only strengthens the theory of greater availability.

Jessie E. Richardson,
Helen L. Mayfield
Home Economics Department,
Montana Agricultural
Experiment Station

BOOKS RECEIVED

Barkhausen, H. *Einführung in die Schwingungslehre nebst Anwendungen auf mechanische und elektrische Schwungungen.* Pp. vii + 128. Hirzel. $6.50.

Bingham, Harold C. *Gorillas in a Native Habitat.* Pp. 66. Carnegie Institution.

Conzemius, Eduard. *Ethnographical Survey of the Miskito and Sumu Indians of Honduras and Nicaragua.* Pp. vi + 191. Illustrated. Smithsonian Institution. $.25.

Hurst, C. C. *The Mechanism of Creative Evolution.* Pp. xxi + 365. Macmillan. $6.00.

Obold, Walter L. and Margaret M. Diehm. *Manual of Microbiology.* Pp. 140. 40 figures. Davis. $1.25.

Sondern, Frederic E. Editor, and others. *Outline of Preventive Medicine.* Pp. xix + 462. Hoeber. $5.00.

Wells, H. G., Julian Huxley and G. P. Wells. *Evolution, Fact and Theory.* Pp. 314–643. Illustrated. $1.00. *The Human Mind and the Behavior of Man.* Pp. 1270–1435. Illustrated. $1.00. *Reproduction, Genetics and the Development of Sex.* Pp. 436–575. Illustrated. $1.00. Doubleday, Doran.

Wilson, Charles B. *The Copepods of the Woods Hole Region, Massachusetts.* Pp. xix + 635. 41 plates. 316 figures. U. S. National Museum, Smithsonian Institution. $.75.